International Journal of Industrial Engineering & Technology (IJIET)
ISSN(P): 2277-4769; ISSN(E): 2278-9456
Vol. 4, Issue 2, Apr 2014, 19-26
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WOVEN FABRICS COMBINATION FOR ACOUSTICS OF BUILDING INTERIOR

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ABSTRACT

Today much importance is given to the acoustical environment. Noise control and its principles play a major role in creating an acoustically pleasing environment. Since long the textile materials are use for wall covering. Today combinations of fabrics are use for wall covering not only for decorative purpose but also for reduce the intensity of sound and brought down for acoustic purpose. Textile materials are fibrous and porous materials have been accepted as sound absorptive materials. This research paper woven fabric are used as cover material and combined with of nonwoven fabric as backing material to study the sound absorption behavior. Also the effects of different fabric properties on sound absorption have been studied. Such types of materials with different structure are promising for home interiors, office interiors, and automobile interiors due to their good sound absorption and insulating properties.

KEYWORDS: Acoustics, Air Permeability, Nonwoven, Sound Absorption, Woven Fabrics

INTRODUCTION

In the present age, noise is an ever-increasing problem everywhere in the world, especially in the developing countries where the Government regulation is not been enforced against public disturbances. Sources of noise are now on the increase and they are steadily growing louder. Noise has become serious environment pollution in the daily life and is an increasing public health problem. A statement issued by Central Pollution Control Board (CPCB), stated 'Living in Chennai is equivalent to living in a factory – at least in terms of how much noise all the residents are subjected to.' The data showed that the noise levels everywhere in Chennai are over 100 dB – more than a typical factory. Real time data from 25 noise pollution monitors in Delhi, Mumbai, Bangalore, Chennai and Hyderabad shows that major city spots, which are being monitored, have registered maximum noise. These levels could cause hypertension, psychological diseases and depression.

Sound absorption is a phenomenon in which the energy of sound waves is reduced as it passes through a material. The materials which absorb sound are known as sound absorptive materials. Several types of sound absorbing materials are available for noise control applications. Absorptive materials are generally resistive in nature, e.g. nonwovens, fibrous glass, mineral wools, felt and foams. The performance of absorptive materials depends on many parameters like GSM, thickness, air permeability, structures, orientation of yarn and fibers. The nonwoven fabrics are widely used as back up material due to its different structure, orientation of fibers, different method of manufacturing techniques and type of bonding. The fibers in the nonwoven fabric may have predominantly longitudinal, cross or isotropic orientation, which are the most suitable for the sound absorbing mechanism. There are mainly four factors to be considered in choosing a sound

absorbing material for a wall covering viz. Appearance, Acoustic performance, Environment and Price. In this research work, different woven fabrics as cover material, along with the nonwoven fabric as back-up material are used to study the reduction in the level of sound. Also the effects of different fabric properties on the sound absorption properties have been studied.

Advantages of Woven Fabrics

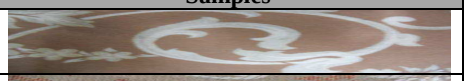
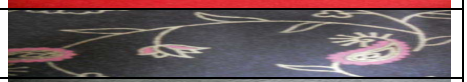
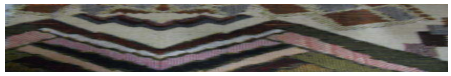
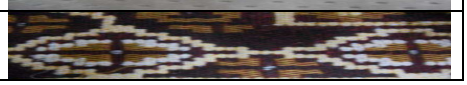
Woven fabrics offer a lot of advantages over other newly developed fabric manufacturing methods, which may be listed as follows:

- Different weaves can be used to make a variety of fabrics having a wide range of properties.
- Fabrics with a wide range of properties viz. heavy, light, open, dense, etc. can be woven.
- Weaving of all types of yarns from natural to synthetic is possible on weaving machines.
- Different methods are available for weaving variety of fabrics viz. tappet, dobby, jacquard, etc.
- The method is well developed and cheap labour is available.
- The cost of weaving a fabric is low compared to other methods of fabric forming.
- Special finishes can be given to the fabrics so that they can be soil resistant, water repellant, etc

MATERIALS

In the wall covering, the cover fabric have main importance to give the decorative and aesthetic appearance, so different variety of woven fabrics procured from market like Velvet, Denim, Jacquard, etc. have been selected based on its characteristics and method of manufacturing. The fabrics selected have different GSM and Thickness as given in Table 1

Table 1: Specification and Coding of Cover Fabrics

Sr. No.	Code	Specification	GSM	Thickness (mm)	Samples
1	T1	Brown Jacquard Woven	134	0.43	
2	T2	Brown Jacquard Woven	188	0.39	
3	T3	Plain Woven / Open Structure	192	0.51	
4	T4	Printed Brown	204	0.46	
5	T5	Grey Velvet with Knitted Back-up	228	1.20	
6	T6	Maroon Jacquard Woven Two Side Fabric	260	1.05	
7	T7	Brown Velvet (Woven Back-up)	291	1.12	
8	T8	Denim	323	0.76	
9	T9	One Side Laminated	483	1.35	
10	T10	Maroon Jacquard Woven	744	2.57	

The needle punched nonwoven fabrics are made from polyester having different GSM and Thickness has been used as back up material. The nonwoven fabric has been supplied by Ravi Industry, Jaipur. The details of the samples are given in Table 2.

Table 2: Specification and Coding of Back-up Fabrics

Sr. No.	Code	Material	GSM	Thickness(mm)	Samples
1	N1	Polyester	500	4.65	
2	N2	Polyester	750	25	
3	N3	Polyester	1000	35	

METHODOLOGY

The sound reduction of the fabric has been measured by the "Steady State Method" as per the ASTM E336-71. The experimental setup is shown in Figure 1.

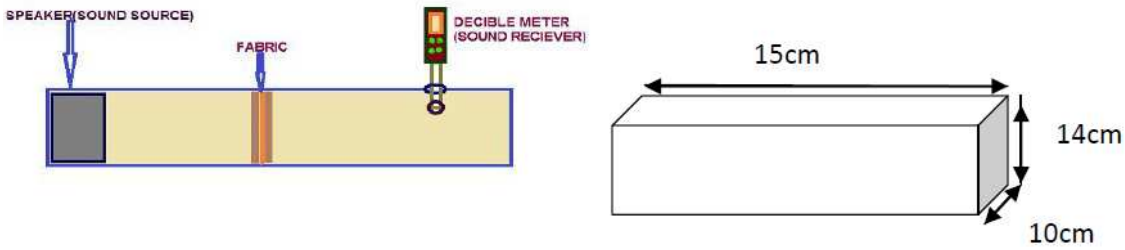


Figure 1: Experimental Setup

The single layer woven cover fabric along with non woven fabric back-up has been taken for measuring the sound reduction. Initially, the level of sound in the box was measured without placing the fabric, which has been taken as reference. Then the fabric sample mounted between the source and receiver and then sound reduction level has been measured. The difference between these two results gave values of sound reduction. The fabric mounted at different between the source and the receiver. The steps involves for experiments are mounting the sound source and sound receiver, adjust sound level, sample mounting, adjust the distance between the fabric and sound receiver, adjust the distance between the fabric and sound source and calculate the sound reduction value.

RESULT AND DISCUSSIONS

Sound Reduction by Cover Fabric

The ten woven fabrics samples have been taken for studied in this project for sound reduction taking equal distance interval of 5cm and up to 20cm. The Figure 2(a) shows the air permeability and GSM value of woven cover fabrics. The air permeability of fabric depends on structure of the fabric, thickness and number of the layers. The sample T3 having plain woven structure (open structure) hence show low GSM but shows high air permeability. Similarly sample T9 shows lower air permeability due to laminated at back side of fabric. This type of laminated fabric shows lower air permeability value due to the coating provided on the surface of the fabric which blocks the porosity of the fabric hence, air cannot easily pass through it. The sample T5 and T6 having higher air permeability compare to other fabric in spite of

high thickness and GSM value that is due to the structure is loss and due to extra thread or velvet effect fabric have more thickness but more air permeability. Similarly sample T8 Denim fabric have less thickness but compact structure hence having gives less air permeability.

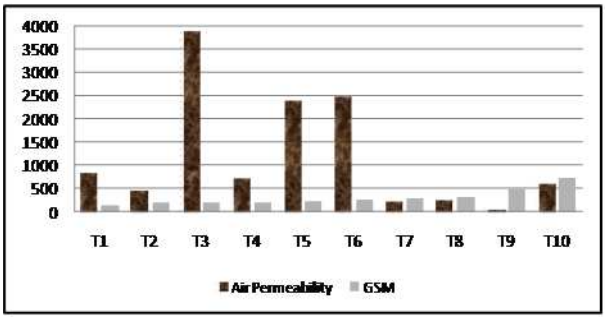


Figure 2(a): Air Permeability and GSM of Different Woven Cover Fabrics

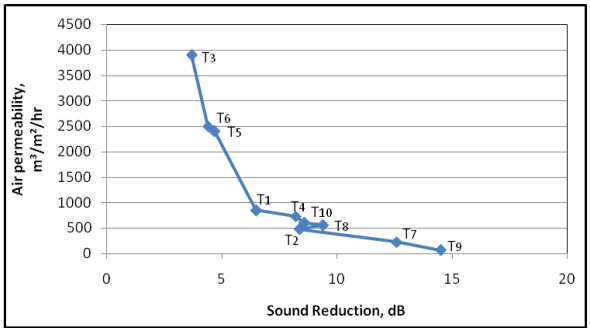


Figure 2(b): Air Permeability vs. Sound Reduction (at 20cm)

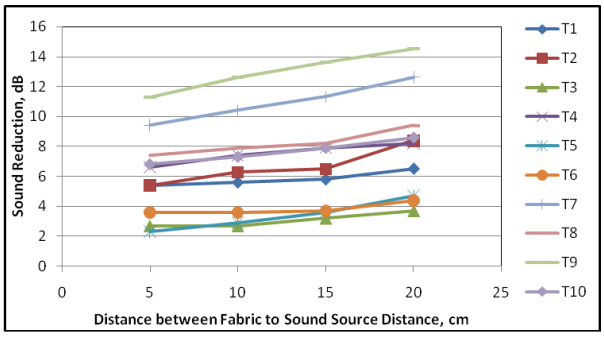


Figure 2(c): Sound Reduction vs. Distance

The trend shown in Figure 2(b) indicates clearly that reduction in the sound level is more for fabrics having less air permeability. Hence, sample T3 shows lowest sound reduction because of high air permeability and sample T9 shows highest sound reduction because of its low air permeability. The sound reduction is also affected by distance between sound sources to fabric. The Figure 2(c) shows that as the distance between fabric and sound source increases the sound reduction also increases. The standard value set at 20cm for all sample. The best sound reduction value has been found at 20cm almost in all samples.

Sound Reduction by Nonwoven Fabric

The Needle punch nonwoven fabric has been selected as back up material. Three different nonwoven samples have been tested in this project as a back-up material for the wall covering. The characteristics of nonwoven fabric greatly

affect by structural parameter like fibre orientation, fibre density, Porosity etc. The Sample N3 having maximum thickness, GSM and lowest air permeability that may be due to less compact structure. It shows negative correlation between GSM and Air permeability. The air permeability and GSM of different nonwoven fabrics are shown in the Figure 3(a). The N1 fabric has highest air permeability and lowest GSM. Similarly N3 have lowest air permeability and highest GSM.

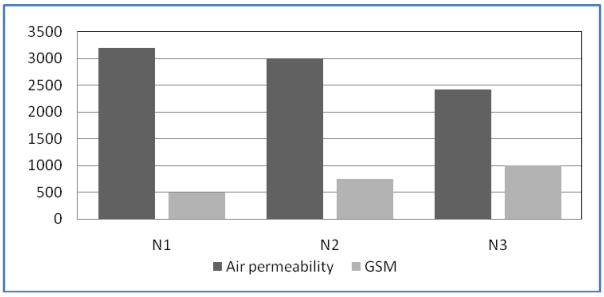


Figure 3(a): Air Permeability and GSM of Different Nonwoven Back-up Fabrics

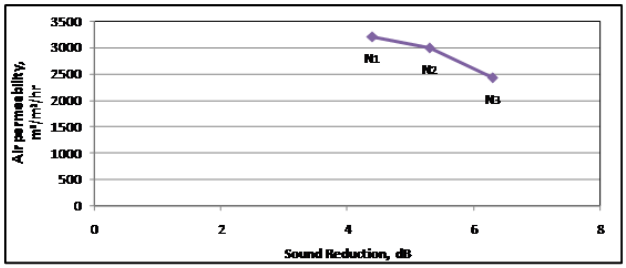


Figure 3(b): Air Permeability vs. Sound Reduction (at 20cm)

The relation between the air permeability and sound reduction has been shown in the Figure 3(b). The sound reduction increases with decrease in the air permeability of the nonwoven. The sample N1 shows higher air permeability and lowest sound reduction whereas the sample N3 shows the lowest air permeability and highest sound reduction.

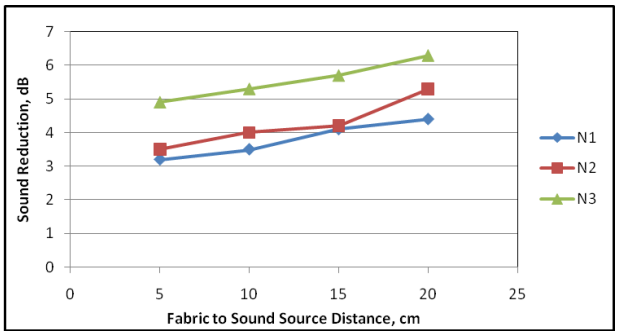


Figure 3(c): Sound Reduction vs. Distance

The sound reduction at different distance between the fabric and sound source has been shown in the Figure 3(c). The sound reduction increases as the distance between the fabric and sound source increases. N3 shows the higher sound reduction at all the distance between the fabric and sound source and N1 shows the lowest sound reduction compared to other fabrics.

- **Sound Reduction of Woven Fabric + Nonwoven Fabric**

The cover fabric alone does not show significant change in sound reduction properties. Hence, a combination of woven fabric as cover material and nonwoven fabric as back-up material was done and then the testing was carried out.

The results for change in sound reduction properties are given in Table 3.

Table 3: Sound Reduction of Woven Fabric + Nonwoven Fabric

Sr. No.	Sample	Air Permeability	Sound Reduction in dB			
			5 cm	10 cm	15 cm	20 cm
N1						
1	T2 + N1	600	8.2	8.6	9.4	10.7
2	T7 + N1	400	9.6	11.4	12	14
3	T8 + N1	575	8.4	8.8	9.2	10.5
4	T9 + N1	225	10.9	12.4	13	14.7
5	T10 + N1	750	7.8	8.5	9.4	10.8
N2						
1	T2 + N2	1200	6.9	8.3	10.2	10.5
2	T9 + N2	1000	9.8	11.2	12.8	13.3
3	T10 + N2	1300	7.2	8.2	9.5	9.8
N3						
1	T7 + N3	1400	9.8	11.2	12.5	12.7
2	T8 + N3	1500	7.2	7.9	9.6	10.1
3	T9 + N3	1300	10.5	11.2	13.4	12.7
4	T10 + N3	1500	7.6	8.5	9.8	9.9

The sound proof walls are made by using the three to four layers of different materials. The verities of the materials are used for making the sound proof wall. Generally for making the sound proof wall the first layer is cover fabrics which are the selected based on its look, feel and application. The second layers used the fibrous materials as backup materials. In this layer different types of fibers (Rock wool, fiber glass) or nonwoven fabrics are used and these layers are mainly responsible for the absorbing sound.

The above results show that by using a cover fabric having lower air permeability, the combined air permeability of the cover and back-up fabric is lower compared to other samples and hence more sound reduction is obtained. This can be seen in the sample combination of T9 and N1 whose air permeability are respectively 65 and 3200, giving a combined permeability of 225, lowest compared to other samples and hence gives highest sound reduction. Hence Combination of woven and nonwoven fabric gives improvement in sound reduction properties.

CONCLUSIONS

On the basis of the experiment conducted to study the sound absorption properties of the different textile materials the following conclusion has been drawn:

- The sound absorbing capacity of acoustic fabric has been found to be function of a number of complex variables like nature of fabric, air permeability, thickness, GSM, distance and level of sound. Air permeability had a negative effect on the sound absorbing capacity.
- The sound absorption properties and air permeability of the cover fabrics depends on the compactness of the structure, design of fabrics and surface finish.
- In nonwoven fabrics, the variation in sound absorption has been evaluated by considering its GSM and thickness values. It has been observed that the GSM and thickness of nonwoven fabrics affect the sound absorption properties. The sound absorption of the fabric increases with the GSM and thickness of the sample.

- The sound reduction by the sample increased with the increase in the distance between the fabric and sound source. At 20cm distance maximum sound reduction value can be obtained. But when the distance between the fabric and sound receiver cannot give significant effect on sound absorption of the samples.
- In all the combinations, the combination of the cover fabric T9 and back-up fabric N1 shows the best sound reduction between 10 to 15dB.

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